Scattering Studies Based On The Method of Ordered Multiple Interactions (MOMI)

FINAL PROGRESS REPORT

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13. ABSTRACT *(Maximum 200 words)*

This report summarizes findings pertaining to the current sampling that is required for the Method of Ordered Multiple Interaction or any Method of Moments solution for scattering from roughened planar surfaces. The results are valid for both a Gaussian roughness spectrum and a power low spectrum having a 2-D asymptotic roll off of k^{-3}.

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PROBLEM, MOST IMPORTANT RESULTS, AND SUMMARY:

Conventional wisdom for sampling the current on a perfectly conducting scattering body holds that $0.1\lambda_o$ is an adequate sample spacing. This result applies to bodies that are usually large compared to a wavelength and which have no features that are comparable to or smaller than one electromagnetic wavelength (λ_o). When dealing with scattering from rough surfaces that have ***many scales*** of roughness, this conventional wisdom is highly suspect. The intent of the research reported below was to study this problem and to attempt to come up with some guidelines for sampling the current on such a rough surface.

In this research we examined the Fourier transform of both the kernel or propagator in the Magnetic Field Integral Equation (MFIE) and the Kirchhoff term and found them both to be essentially band-limited. That is, we found that they both became very small in magnitude outside a band of wavenumbers determined by the electromagnetic wavenumber (k_o) and the upper cut-off wavenumber of the surface roughness spectrum (k_c). The fundamental implication of this result is that the current itself will also be band-limited and this fact was verified by computation using either a standard Method of Moments (MoM) approach or the Method of Ordered Multiple Interactions (MOMI).

Since all the functions in the integral equation are band-limited, the unknown current can be best reconstructed using $\sin(\alpha x)/(\alpha x)$ testing and basis functions sampled at a Nyquist rate of twice the highest wavenumber present in the functions, i.e.,

$$2k_u = 2(k_o + k_c)$$

which leads to a sampling interval Δx given by

$$\Delta x = \frac{\lambda_o}{2(1 + k_c / k_o)}.$$

It should be noted that this sampling procedure is the direct opposite of what is usually used in MoM-type solutions. That is, we use basis and testing functions that have infinite support in the spatial domain while having a finite support in the transform domain whereas in conventional MoM approaches one uses rectangular basis functions in the spatial domain. Based on the above discussion as to the band-limited nature of the functions in the integral equation for rough surfaces having band-limited or cut-off roughness spectra, it is clear why the infinite spatial support interpolating functions should be used.

An additional result that comes from this analysis is the fact that when one uses the above interpolating functions in discretizing the integral equation for the current, the question of how to deal with the propagator is answered with no ambiguity.